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Takata

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(54) **LIGHTING DEVICE FOR DISPLAY DEVICE AND DISPLAY USING THE SAME**

2010/0008069 A1* 1/2010 Takata 362/97.1

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 358 days.

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OTHER PUBLICATIONS

(21) Appl. No.: **11/911,741**

Yoshiki Takata; "Illumination Apparatus for Display Device, Display Device Using the Same, and Television Receiver Apparatus Comprising the Display Device," U.S. Appl. No. 12/014,118; filed Jan. 15, 2008.

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(2), (4) Date: **Oct. 17, 2007**

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(57) **ABSTRACT**

(65) **Prior Publication Data**

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A backlight device includes a light guide plate opposed to fluorescent tubes, a diffusion sheet stacked on the light guide plate, and lens sheets further stacked on the diffusion sheet. A tip end of a corner portion of the diffusion sheet has a shape defined by removing a portion of the sheet along a straight line spanning between two sides constituting the corner portion. In first of the lens sheets, a tip end portion of a corner portion formed by two sides has a shape defined by removing a portion of the sheet in a larger amount than in the diffusion sheet by a circular arc which projects outward. In a second of the lens sheets, a tip end of a corner portion formed by two sides has a shape defined by removing a larger amount than in the first of the lens sheets along a straight line.

(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
G09F 13/04 (2006.01)

(52) **U.S. Cl.** 362/97.1; 362/311.06

(58) **Field of Classification Search** 362/97.1-97.4,
362/311.04, 311.06

See application file for complete search history.

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6 Claims, 7 Drawing Sheets

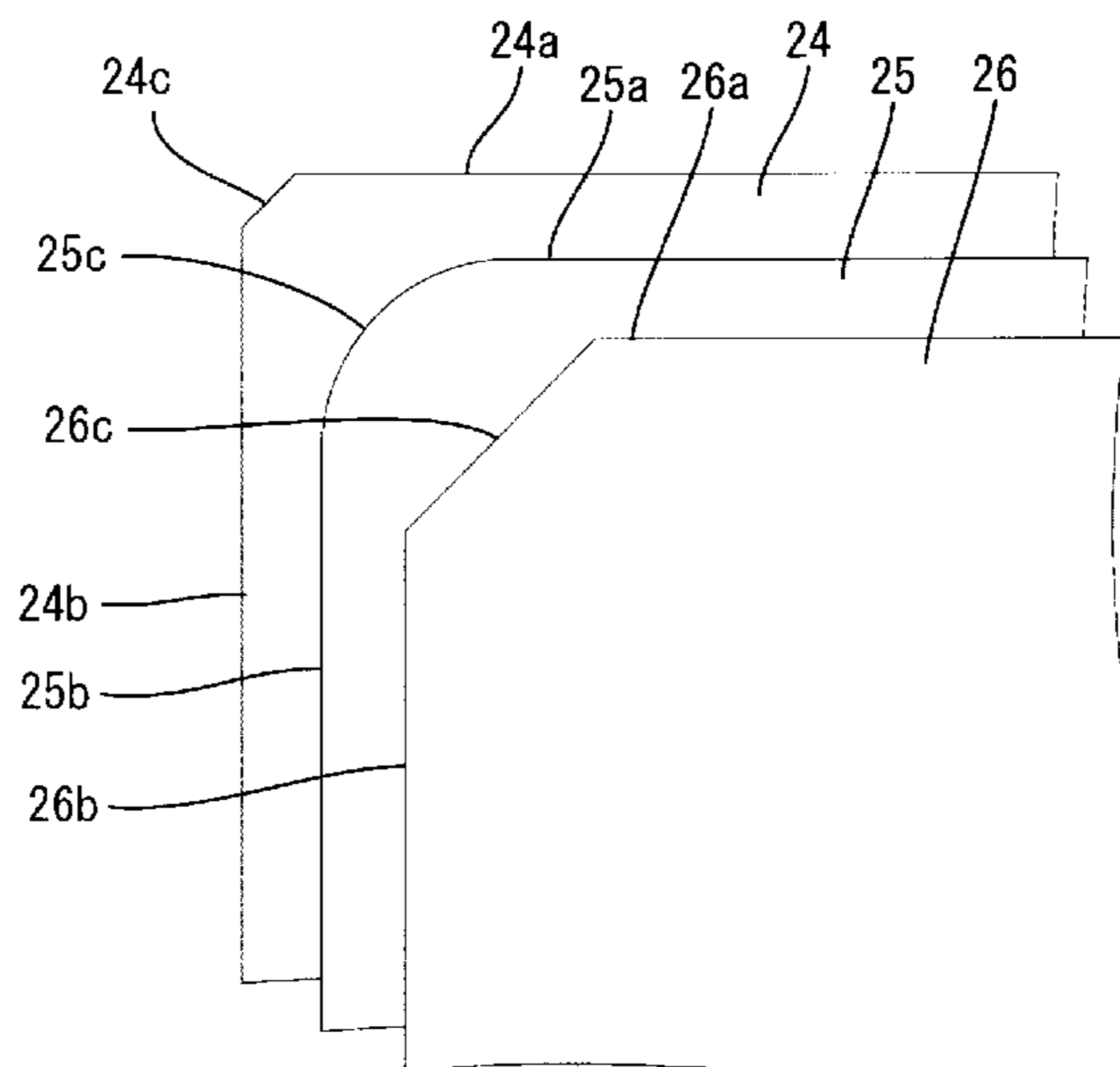


FIG. 1

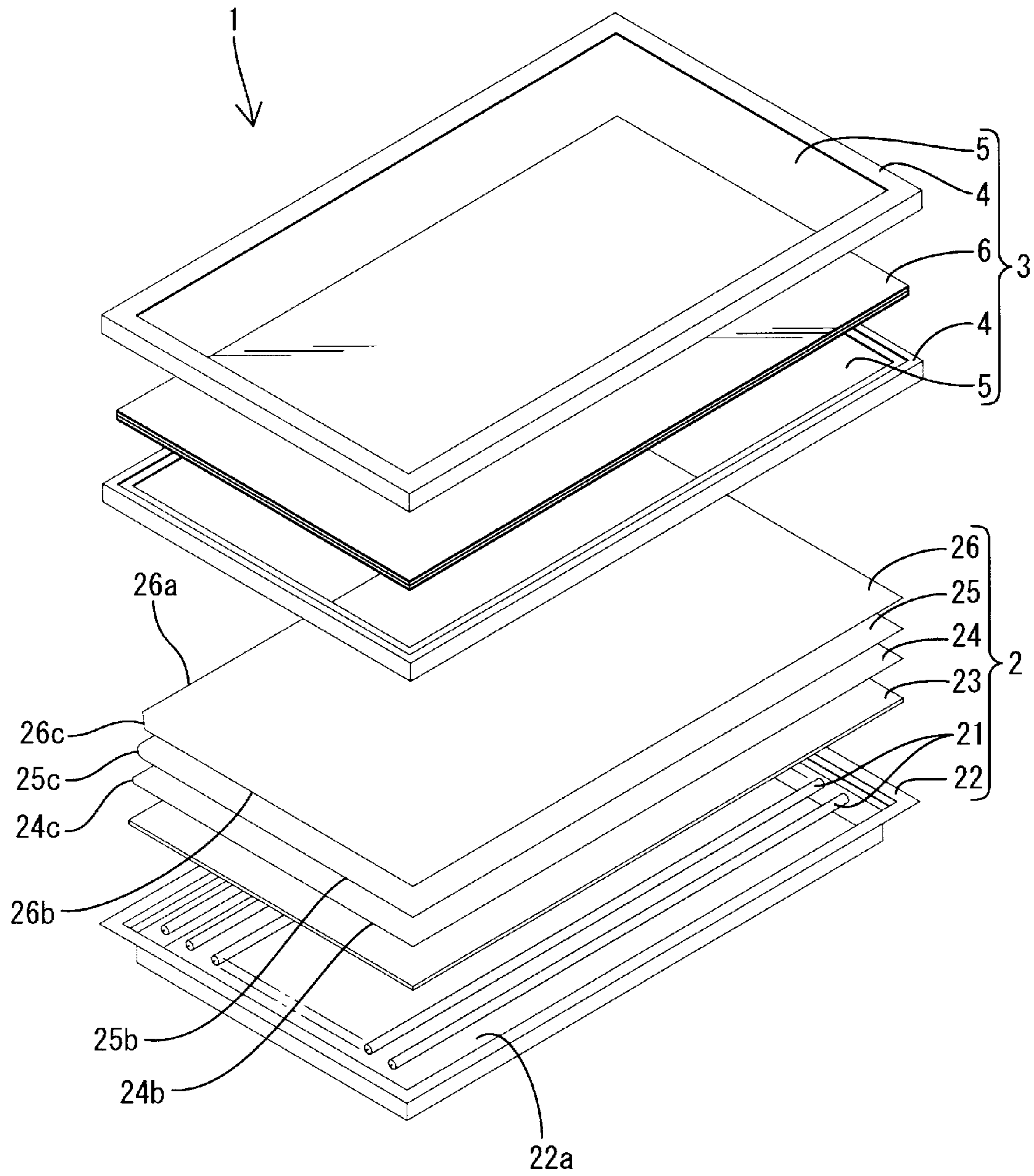


FIG.2A

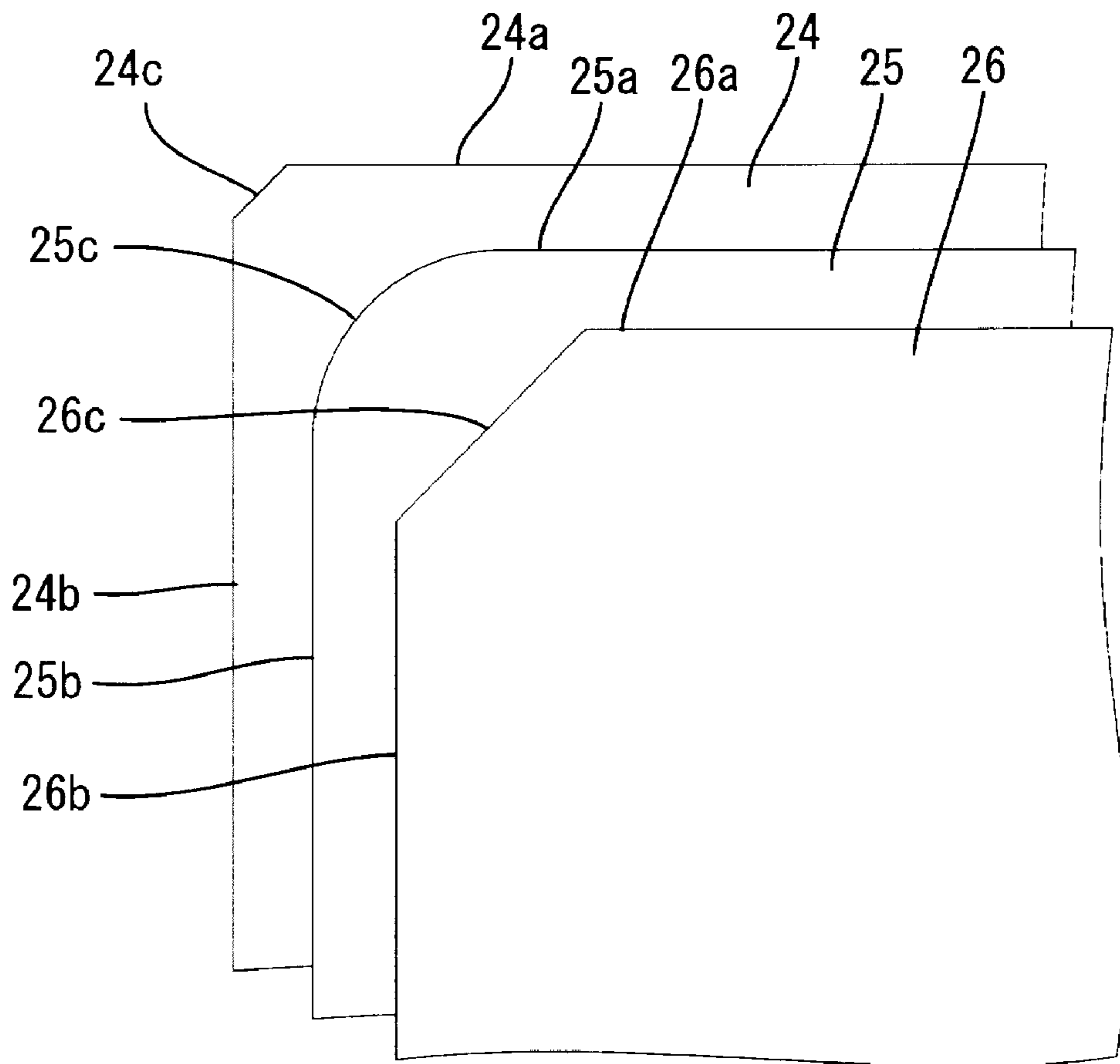


FIG.2B

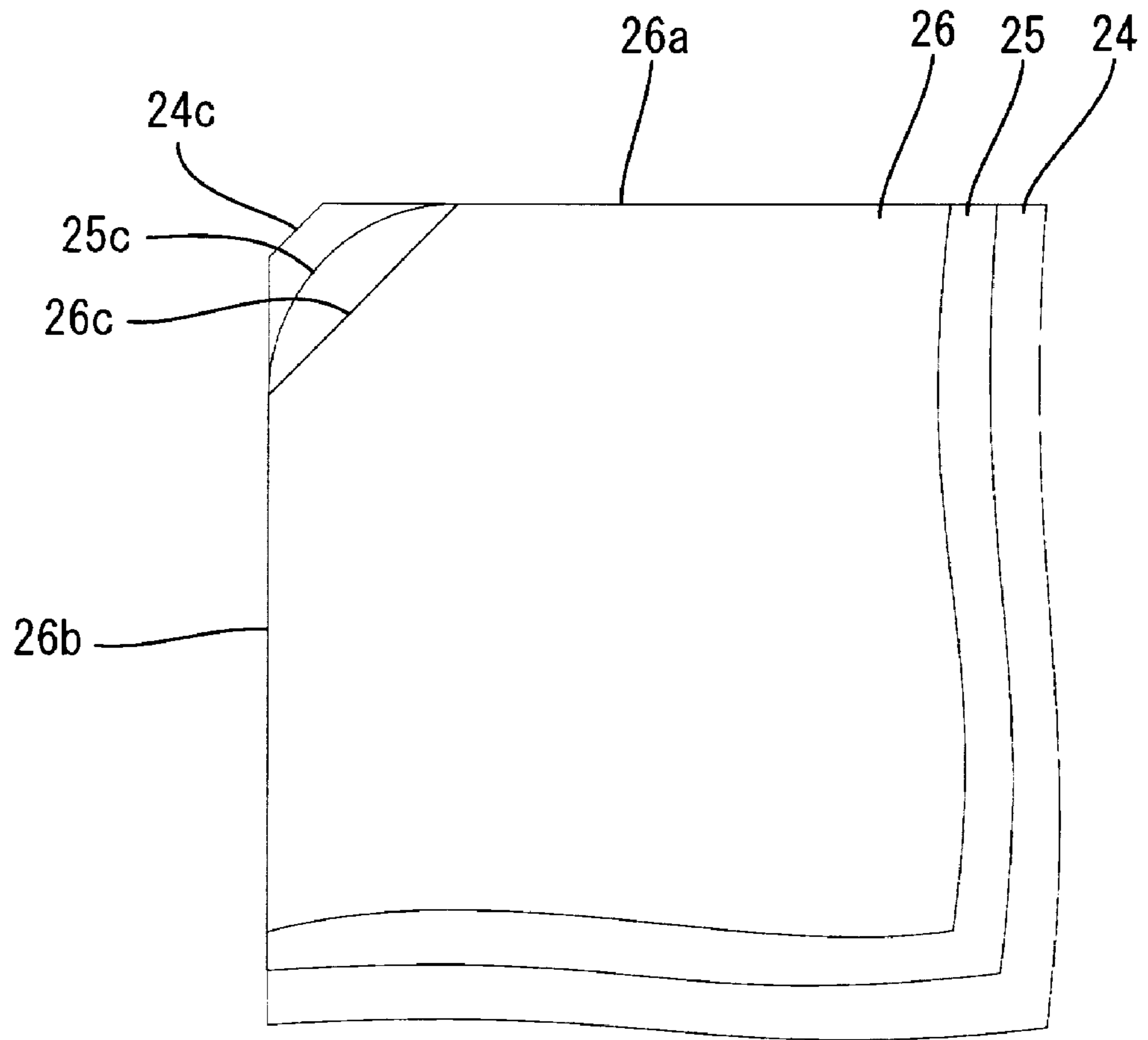


FIG.3A

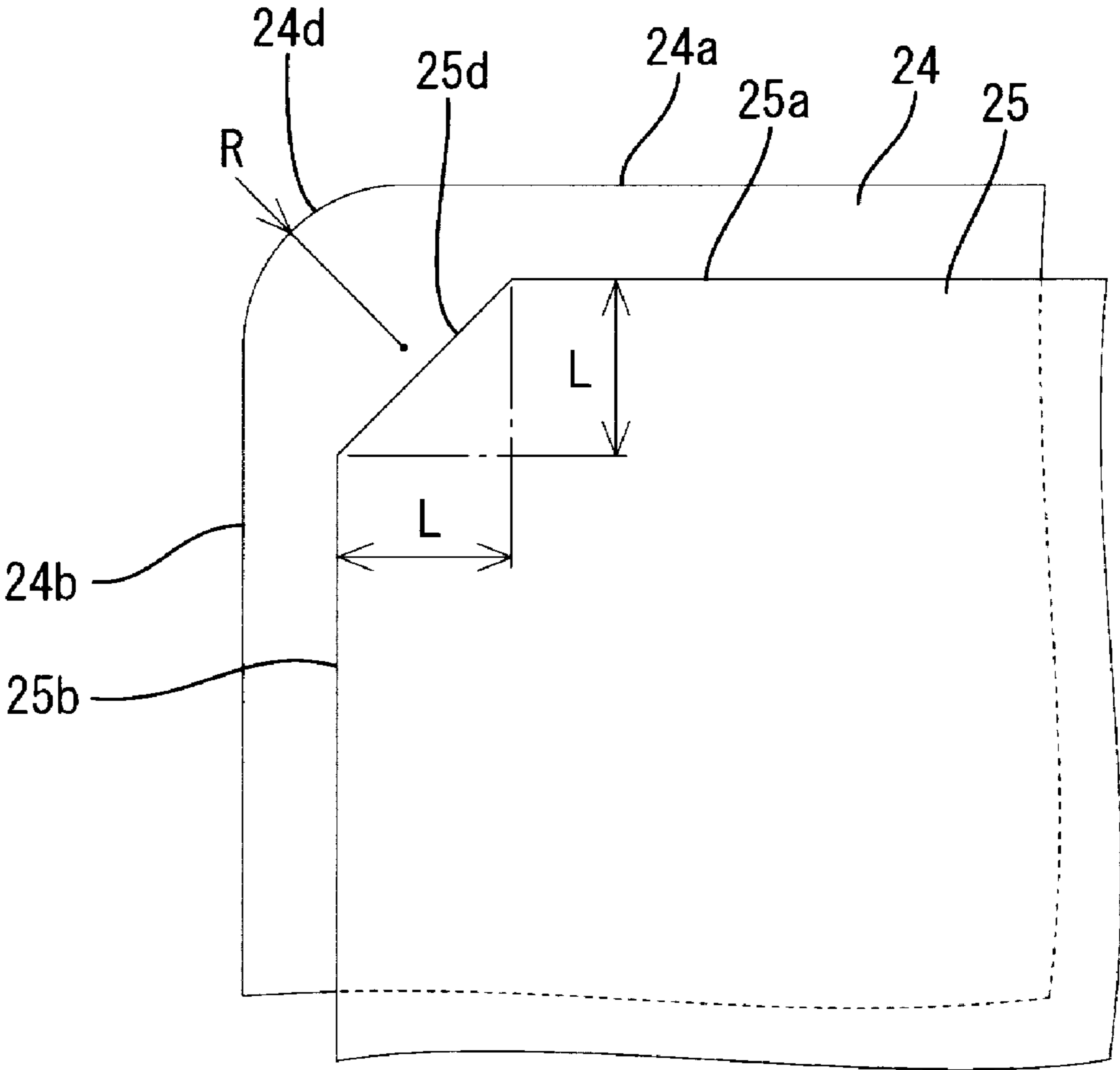


FIG.3B

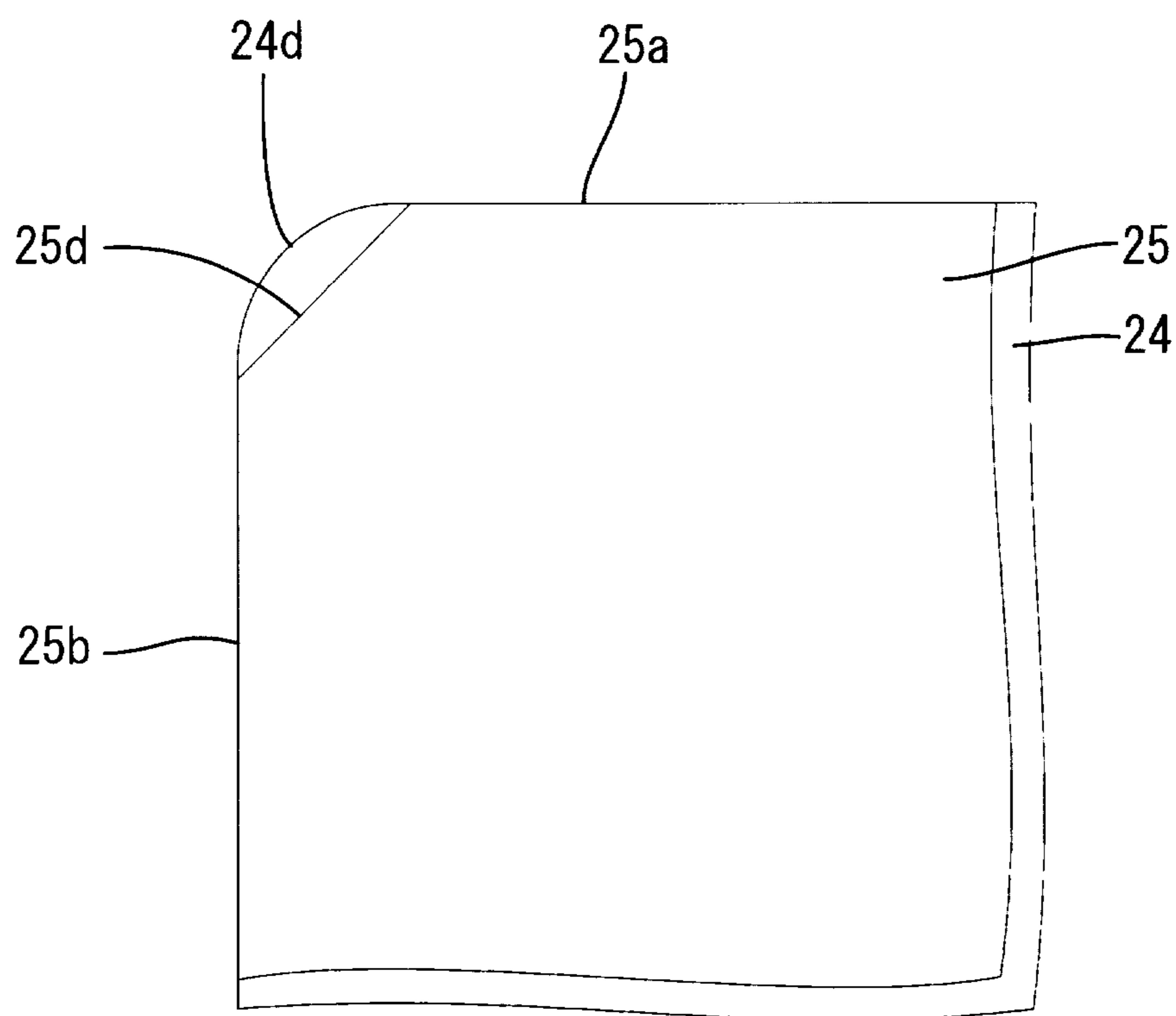


FIG.4A

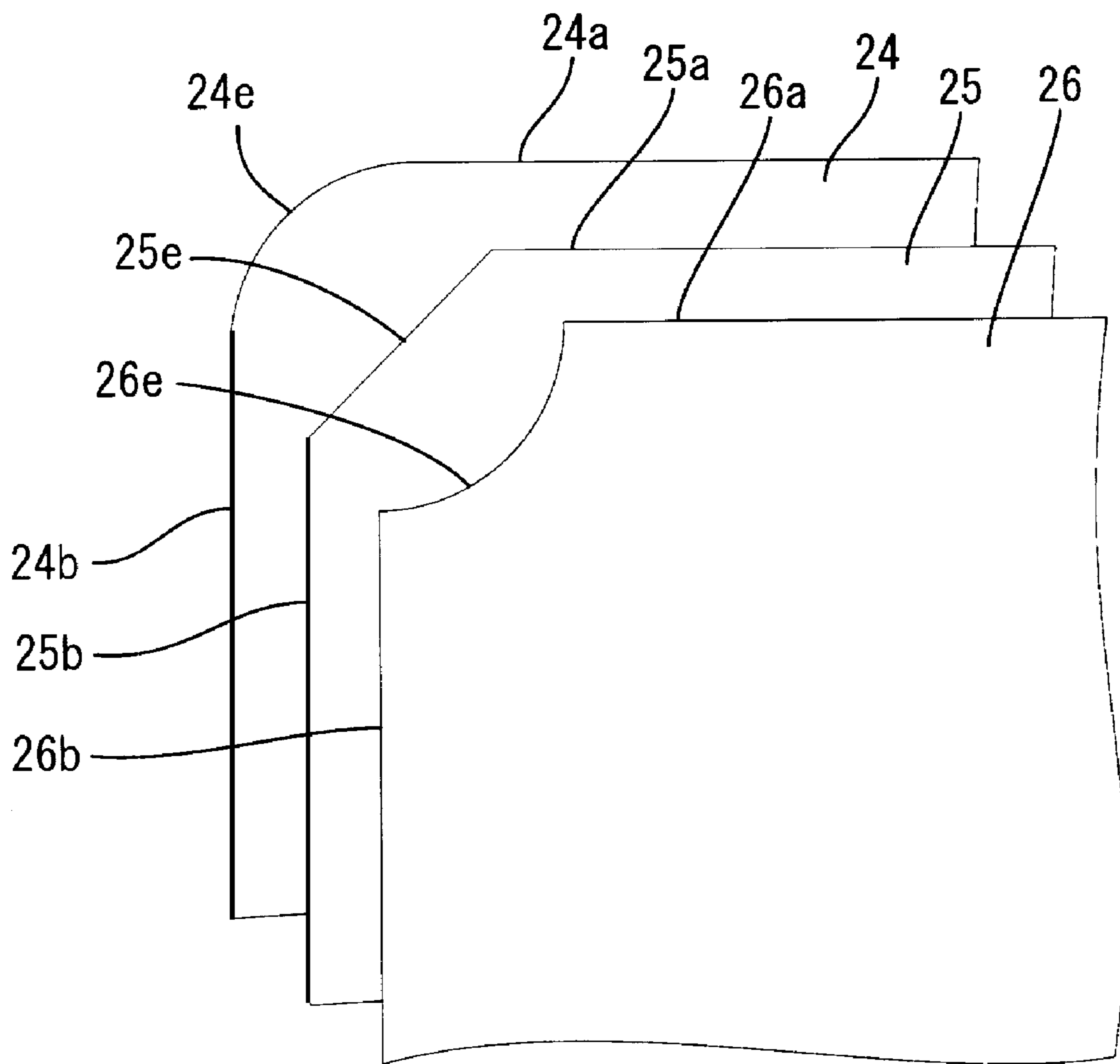
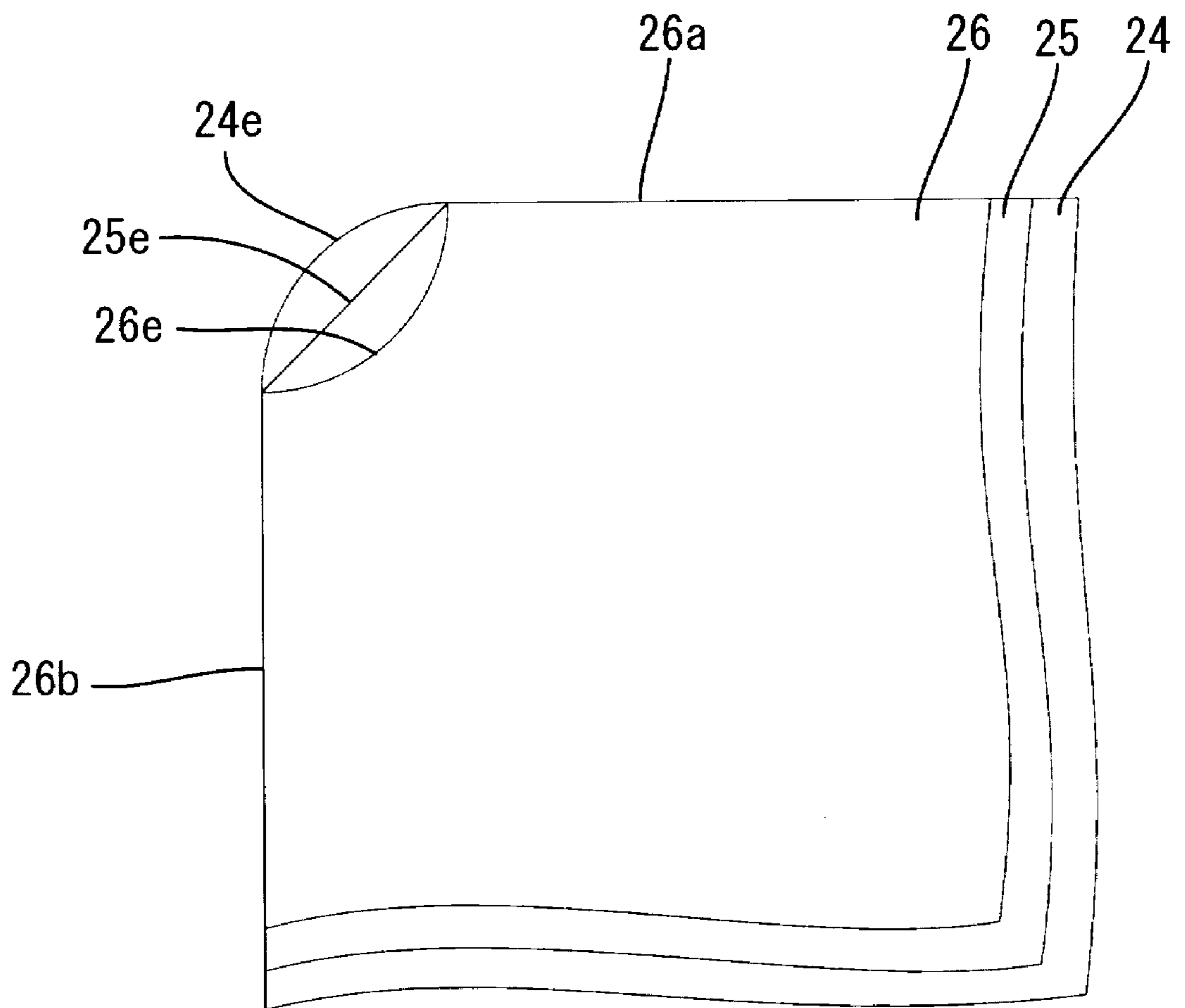


FIG.4B



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LIGHTING DEVICE FOR DISPLAY DEVICE AND DISPLAY USING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a lighting device for a display device which is used for a liquid crystal panel or the like, and a display device using the same.

2. Description of the Related Art

Japanese Patent Application Laid-Open No. 2004-125964 (FIG. 2) discloses a prior art backlight device for a liquid crystal display. In this backlight device, a plurality of optical films are stacked on each other and opposed to a housing portion of a light source such that light emission from the light source is uniformly irradiated to a display.

A backlight device has to include the plurality of optical sheets without omitting any of the sheets in its assembled state. However, a plurality of optical sheets usually appear to have the same or similar thin sheet shapes, and when they are seen from above in a stacked state, they cannot be discriminated from one another. Therefore, it is difficult to check for the presence of the plurality of optical sheets in the device. Thus, in the backlight device according to the above described prior art, the corner portion of each of the optical sheets is cut off along a straight line, and the cutoff amounts are made to differ in accordance with the respective sheets (the triangular shapes which are cut off from the respective sheets have the same or similar shapes to one another). The sheet with the smallest cutoff amount is on the bottom, and the sheets with larger cutoff amounts are sequentially stacked on top of one another. In this way, the cutoff portions are seen from above during the manufacturing process, so that the lack or absence of one or more of the optical sheets in the assembly is detected.

However, an optical sheet must have a minimum predetermined surface area for maintaining a light control function. Thus, the cutoff portion on each optical sheet must be as small as possible. Accordingly, it is still difficult to see the corner portions cut off along the straight lines and determine the absence of the optical sheets in the manufacturing process.

SUMMARY OF THE INVENTION

In order to overcome the problems described above, preferred embodiments of the present invention provide a lighting device for a display device in which the absence of one or more of a plurality of optical sheets can be easily detected, and a display device including such a lighting device.

A lighting device for a display device according to a preferred embodiment of the present invention includes a plurality of optical sheets each having corner portions and having a shape in which a tip end of the corner portion is removed along a line segment spanning between two sides constituting the corner portion, and a sheet layered body disposed near a light source defined by the plurality of the optical sheets being stacked on each other in an order of size of the remaining portions of the corner portions, the optical sheets having the largest remaining portion being the first in the stack or on the bottom of the stack, and wherein shapes of the line segments spanning between respective two sides constituting the corner portions of adjacent ones of the plurality of the optical sheets differ from each other.

With such a unique structure, if any one of the optical sheets is absent, the arrangement of the line segments differing in shape from one another becomes abnormal, and a sense

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of incompatibility the absence of one or more of the optical sheets can be visually detected instantly.

Other features, elements, steps, characteristics and advantages of the present invention will be described below with reference to preferred embodiments thereof and the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded perspective view of a liquid crystal display according to a first preferred embodiment of the present invention.

FIG. 2A is a plane view showing the state before stacking of a sheet layered body constituting the liquid crystal display shown in FIG. 1.

FIG. 2B is a plane view showing the stacked state of a sheet layered body shown in FIG. 2A.

FIG. 3A is a plane view showing the state before stacking of a sheet layered body according to a second preferred embodiment of the present invention.

FIG. 3B is a plane view showing the stacked state of a sheet layered body shown in FIG. 3A.

FIG. 4A is a plane view showing the state before stacking of a sheet layered body according to a third preferred embodiment 3.

FIG. 4B is a plane view showing the stacked state of a sheet layered body shown in FIG. 4A.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

First Preferred Embodiment

A first preferred embodiment of the present invention will be described with reference to FIGS. 1, 2A and 2B. A liquid crystal display 1 according to this preferred embodiment is a display device, and preferably includes a backlight device 2, which is a lighting device for a display device, and a display panel 3, which is a display and is disposed in front of the backlight device 2 and capable of displaying images. The backlight device 2 preferably is a direct type backlight device including a tray 22 housing a plurality of fluorescent tubes 21, a light guide plate 23 made of a synthetic resin and disposed over the tray 22, a diffusion sheet 24 disposed on the light guide plate 23, and two lens sheets 25 and 26 further disposed on the diffusion sheet 24. However, the backlight device 2 is not limited to this configuration. As shown in FIG. 1, the diffusion sheet 24 and the lens sheets 25 and 26 are preferably optical sheets formed of a synthetic resin. Each of the optical sheets preferably has a substantially rectangular shape in the plane view, and a sheet layered body is defined by the plurality of optical sheets stacked on each other.

As shown in FIG. 1, a reflective sheet 22a is provided in the tray 22, and a plurality of fluorescent tubes 21 are located on the reflective sheet 22a. The respective fluorescent tubes 21 are disposed in parallel or substantially in parallel at equal or substantially equal spaces from one another in the tray 22, and are arranged in a plane configuration as a whole. Meanwhile, the display panel 3 includes a pair of glass boards 5 respectively fitted in frames 4, and a panel board 6 which is fitted between them and is constituted of a pair of transparent electrodes and an alignment layer containing liquid crystal.

As shown in FIG. 2A, each of the diffusion sheet 24 and the lens sheets 25 and 26 preferably has a shape such that a tip end of a corner portion located at one of its four corners is removed by a line segment spanning between two sides constituting the corner portion, and the shapes of the line seg-

ments differ from each other between the adjacent sheets **24** and **25**, and between the adjacent sheets **25** and **26**. Specifically, the diffusion sheet **24** preferably has a shape such that the tip end of the corner portion formed by two sides **24a** and **24b** among its outer sides is removed by a straight or substantially straight line **24c** connecting the two sides **24a** and **24b**. The lens sheet **25** preferably has a shape such that the tip end of the corner portion formed by two sides **25a** and **25b** is removed by a circular or substantially circular arc **25c** projected outward and connecting the two sides **25a** and **25b**. The lens sheet **26** preferably has a shape such that the tip end of the corner portion formed by two sides **26a** and **26b** is removed by a straight or substantially straight line **26c** connecting the two sides **26a** and **26b**.

The line segments **24c** and **26c** which remove the tip ends of the corner portions of the sheets **24** and **26** are preferably arranged to define an angle of about 45° with respect to the outer sides **24a** and **24b**, and **26a** and **26b** of the sheets **24** and **26**. However, the line segments **24c** and **26c** are not limited to this, and the circular or substantially circular arc **25c** which removes the tip end of the corner portion of the sheet **25** is preferably formed by a quarter of the circumference of a circle with a predetermined radius. As shown in FIG. 2B, the diffusion sheet **24** and the lens sheets **25** and **26** are stacked in the order of the size of the removed portions, with the optical sheet having the smallest removed portion being the first sheet (in other words, they are stacked in the order of the size of the remaining portion, the largest remaining portion being stacked first or on the bottom of the stack). The end portions of the circular or substantially circular arc **25c** of the lens sheet **25** are connected by the straight or substantially straight line **26c** of the lens sheet **26** which is stacked on the lens sheet **25**. The sheets **24**, **25** and **26** may be formed by actually cutting the corner portions of the sheet members which originally have the substantially rectangular shapes by the straight or substantially straight lines **24c** and **26c** and the circular or substantially circular arc **25c**, respectively, or the sheets **24**, **25** and **26** may be formed into the shapes in which the tip ends of the respective corner portions are originally removed by using molds.

According to this preferred embodiment, the shapes of the line segments **24c**, **25c** and **26c** spanning between the two sides **24a** and **24b**, **25a** and **25b**, and **26a** and **26b** which constitute the corner portions of the diffusion sheet **24** and the lens sheets **25** and **26** differ from each other between the adjacent sheets. Therefore, if any one of these sheets **24**, **25** and **26** which constitute the sheet layered body is absent, the arrangement of the line segments **24c**, **25c** and **26c** differing in shapes from each other becomes irregular, and a sense of incompatibility is instantly visually detected. Therefore, the presence or absence of the sheets **24**, **25** and **26** can be easily determined. Among the adjacent sheets, as for the one sheet **24** of the two adjacent sheets and the one sheet **26** of the two adjacent sheets, the two sides **24a** and **24b**, and the two sides **26a** and **26b**, which constitute the corner portions, are connected by the straight or substantially straight lines **24c** and **26c**, respectively. As for the other sheet **25**, the two sides **25a** and **25b** constituting the corner portion are connected by the curved line (circular or substantially circular arc **25c**), and thereby, the straight or substantially straight lines **24c** and **26c** are adjacent to the curved line **25c**. Therefore, the absence of the sheets **24**, **25** and **26** is detected more easily.

The lens sheet **25** of which two sides **25a** and **25b** constituting the corner portion are connected by the circular or substantially circular arc **25c** so as to project outward is stacked on the diffusion sheet **24** of which two sides **24a** and **24b** constituting the corner portion are connected by the

straight or substantially straight line **24c**. The lens sheet **26** of which two sides **26a** and **26b** constituting the corner portion are connected by the straight or substantially straight line **26c** is further stacked on the lens sheet **25**, and the straight or substantially straight line **26c** of the lens sheet **26** stacked on the lens sheet **25** is located at a position where the straight or substantially straight line **26c** connects the end portions of the circular or substantially circular arc **25c**. Thereby, even when the three sheets **24**, **25** and **26** are laid on one another, the circular or substantially circular arc **25c** and the straight or substantially straight line **26c** do not overlap each other, and they can be clearly discriminated. The straight or substantially straight line **26c** is not located deeply inward away from the circular or substantially circular arc **25c**, and the removed width of the corner portion of the sheet **26** located on the top is not large. Therefore, a compact and lightweight backlight device **2** can be provided. Further, by disposing the display panel **3** in front of the backlight device **2**, the liquid crystal display **1** in which the presence or absence of the sheets **24**, **25** and **26** can be easily determined can be provided.

Second Preferred Embodiment

Next, a second preferred embodiment of the present invention will be described with reference to FIGS. 3A and 3B. In this preferred embodiment, the lens sheet **25** preferably has a shape such that the tip end of the corner portion is removed by a straight or substantially straight line **25d** which connects the outer sides **25a** and **25b** and forms an angle of about 45° relative to the sides **25a** and **25b**, is stacked on the diffusion sheet **24** such that the tip end of the corner portion is removed by a circular or substantially circular arc **24d** formed by a quarter of the circumference which connects the two sides **24a** and **24b** constituting the corner portion and is projected outward. This preferred embodiment may be applied to the lens sheets **25** and **26**. As shown in FIG. 3A, a length *L* in the diagonal direction of the straight or substantially straight line **25d** of the lens sheet **25** is longer than a radius *R* of the circular or substantially circular arc **24d** formed in the diffusion sheet **24**, and the length of the straight or substantially straight line **25d** is longer than the length of the shortcut of the end portions of the circular or substantially circular arc **24d** (shown in FIG. 3B). In this preferred embodiment, the corner portion of the lens sheet **26** which is stacked on the sheet **25** is cut by a circular or substantially circular arc or a straight or substantially straight line so as not to overlap the straight or substantially straight line **25d**. The sheets **24** and **25** may be formed by actually cutting the corner portions of the sheet members which originally have the substantially rectangular shapes by the circular or substantially circular arc **24d** and the straight or substantially straight line **25d**, respectively, or the sheets **24** and **25** may be formed into the shapes in which the tip ends of the respective corner portions are originally removed by using molds.

According to this preferred embodiment, the lens sheet **25** of which two sides **25a** and **25b** constituting the corner portion are connected by the straight or substantially straight line **25d** is stacked on the diffusion sheet **24** of which two sides **24a** and **24b** constituting the corner portion are connected by the circular or substantially circular arc **24d** so as to project outward, and the length of the straight or substantially straight line **25d** is larger than the length of the shortcut of the end portions of the circular or substantially circular arc **24d**. Therefore, in the adjacent sheets **24** and **25**, the straight or substantially straight line **25d** and the circular or substantially circular arc **24d** do not overlap each other, and can be clearly

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discriminated, and therefore, the absence of the sheets **24** and **25** can be detected more easily.

Third Preferred Embodiment

FIGS. **4A** and **4B** show a third preferred embodiment of the present invention. In this preferred embodiment, the lens sheet **25** preferably has a shape such that the tip end of the corner portion is removed by a straight or substantially straight line **25e** which connects the outer sides **25a** and **25b** and defines an angle of about 45° with respect to the sides **25a** and **25b**, is stacked on the diffusion sheet **24** such that the tip end of the corner portion is removed by a circular or substantially circular arc **24e** by a quarter of the circumference which connects the two sides **24a** and **24b** constituting the corner portion and is projected outward. Further, the lens sheet **26** preferably has a shape such that the tip end of the corner portion is removed by a circular or substantially circular arc **26e** (the radius is preferably the same as that of the circular or substantially circular arc **24e**) by a quarter of the circumference which connects the two sides **26a** and **26b** constituting the corner portion and is recessed inward is stacked on the lens sheet **25**. As shown in FIG. **4B**, in this preferred embodiment, the positions of the end portions of the circular or substantially circular arcs **24e** and **26e** of the diffusion sheet **24** and the lens sheet **26** correspond to each other, and the straight or substantially straight line **25e** of the lens sheet **25** is formed to connect these end portions. The sheets **24**, **25** and **26** may be formed by actually cutting the corner portions of the sheet members which originally has the substantially rectangular shapes, by the circular or substantially circular arcs **24e** and **26e** and the straight or substantially straight line **25e**, respectively, or the sheets **24**, **25** and **26** may be formed into the shapes with the tip ends of the respective corner portions originally removed by using molds.

According to this preferred embodiment, the lens sheet **25** of which two sides **25a** and **25b** constituting the corner portions are connected by the straight or substantially straight line **25e** is stacked on the diffusion sheet **24** in which the two sides **24a** and **24b** constituting the corner portion are connected by the circular or substantially circular arc **24e** to project outward. Further, the lens sheet **26** of which two sides **26a** and **26b** constituting the corner portion are connected by the circular or substantially circular arc **26e** so as to recess inward is stacked on the lens sheet **25**. The positions of the end portions of the circular or substantially circular arcs **24e** and **26e** correspond to each other, and the straight or substantially straight line **25e** is located at the position at which it connects these end portions. Thereby, in the corner portions of the sheets **24**, **25** and **26**, the two circular or substantially circular arcs **24e** and **26e** and the straight or substantially straight line **25e** form one closed pattern, and therefore, the absence of the sheets **24**, **25** and **26** can be easily detected at a glance.

Other Preferred Embodiments

The present invention is not limited to the preferred embodiments described above and illustrated in the drawings, but, for example, the following preferred embodiments are also included in the technical scope of the present invention.

The optical sheets in the lighting device for a display device according to various preferred embodiments of the present invention preferably include all light adjusting sheets such as light guide plates, and reflective sheets.

The lighting device for a display device according to various preferred embodiments of the present invention is also applicable to a side light type.

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Cold-cathode tubes, hot-cathode tubes, discharge lamps and the like are applicable to the light source of the lighting device of a display device according to various preferred embodiments of the present invention.

In the lighting device of a display device according to various preferred embodiments of the present invention, the curved lines other than a circular or substantially circular arc, or the straight or substantially straight lines other than that which defines an angle with respect to the outer sides of the sheet being about 45° may be applied to the line segment by which the corner portion is cut.

While preferred embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

The invention claimed is:

1. A lighting device for a display device, comprising:
 - a plurality of optical sheets each having corner portions and each having a shape in which a tip end of one of the corner portions is removed along a line segment spanning between two sides constituting said one of the corner portions so as to produce a remaining portion;
 - a sheet layered body disposed near a light source and including the plurality of optical sheets stacked on each other in an order of size of the remaining portions of said corner portions such that the optical sheets having the largest remaining portions are stacked first; wherein shapes of the line segments spanning between respective two sides constituting the corner portions of adjacent ones of the plurality of the optical sheets differ from each other.
2. The lighting device for a display device according to claim 1, wherein one of the shapes of the line segments of one of the adjacent ones of the plurality of optical sheets is a substantially straight line, and another of the shapes of the line segments of another of the adjacent ones of the plurality of optical sheets is a substantially curved line.
3. The lighting device for a display device according to claim 2, wherein said optical sheet having the line segment that is a substantially straight line is stacked on said optical sheet having the line segment that is a substantially curved line such that the remaining portion defined by the substantially curved line projects outward beyond said optical sheet having the line segment that is a substantially straight line.
4. The lighting device for a display device according to claim 2, wherein said optical sheet having the line segment that is a substantially curved line is stacked on said optical sheet having the line segment that is a substantially straight line, such that the remaining portion defined by the substantially straight line projects outward beyond said optical sheet having the line segment that is a substantially curved line.
5. The lighting device for a display device according to claim 2, wherein said optical sheet having the line segment that is a substantially curved line is stacked on said optical sheet having the line segment that is a substantially straight line, such that the remaining portion defined by the substantially straight line projects outward beyond said optical sheet having the line segment that is a substantially curved line, and another of said optical sheets having the line segment that is a substantially straight line is stacked on said optical sheet having the line segment that is a substantially curved line such that the remaining portion defined by the substantially curved line projects outward beyond said another of said optical

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sheets having the line segment that is a substantially straight line.

6. A display device, comprising:
the lighting device for a display device according to claim **1**; and

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a display disposed in front of the lighting device for a display device.

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